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THE ASTRONOMICAL ACTIVITIES OF PROFESSOR  
GEORGE DAVIDSON.

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BY W. W. CAMPBELL.

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GEORGE DAVIDSON was born in Nottingham, England, on May 9, 1825. Coming to the United States when a boy, he completed the course of study in the Central High School, Philadelphia, in 1845. He entered the service of the United States Coast Survey on June 1, 1845, residing in Washington as secretary to Superintendent BACHE. He also served as a computer and in other capacities.

The needs of navigation for accurate knowledge of the Pacific coast-line were recognized by the authorities in Washington shortly after the territory of California was acquired from Mexico. The first requirements were determinations of the latitudes and longitudes of the prominent capes, headlands and entrances to the harbors, hydrographic surveys of the harbors, and topographic surveys of harbor surroundings. DAVIDSON was the oldest member and the leader of a party of three, consisting of himself, JOHN ROCKWELL and JAMES S. LAWSON, sent to the Pacific Coast shortly after the discovery of gold in California, for the purpose of starting the accurate work of the Coast Survey in this region. The party arrived in the summer of 1850. With the exception of five years, coinciding approximately with the Civil War, DAVIDSON's home was in San Francisco continuously until the date of his death, December 2, 1911. His life was devoted with untiring energy and complete unselfishness to the interests of science on the Pacific Coast. It is no exaggeration to say that during sixty years his name was more familiar to the scientifically-inclined inhabitants of the Pacific Coast region than that of any other resident.

His services were not confined to the requirements of the Coast Survey work. His efficient help was always available to advance any department of science. He was president of the California Academy of Sciences for sixteen years, and president of the Pacific Geographical Society for thirty years. He gave as-

sistance in all lines of investigation undertaken by the Academy. He was an authority on the voyages of the early explorers of the Pacific Coast and on the early history of the Coast. At various times and during periods of different lengths he served on the Irrigation Commission of California, on the Advisory Harbor Improvement Commission for San Francisco, on the Mississippi River Commission, on the United States Assay Commission, as Regent of the University of California, and during the last years of his life as Professor of Geography in the University of California. In June, 1895, he resigned his position in the Coast Survey, at the conclusion of fifty years of service. During the last twenty-seven years of this period he was Assistant in charge of all Coast Survey operations on the Pacific Coast of the United States. His interests in the welfare of the community where he resided were always active and available, and he had the unconscious personal charm and magnetism which made and held strong friends. A worthy biography of Professor DAVIDSON would embrace the wide range of subjects already mentioned, and it is hoped that a competent pen will some day undertake the duty of writing it.

While all branches of knowledge interested Professor DAVIDSON, the subject of astronomy, pure and applied, seemed to make a special appeal to him. He was an authority in the geodetic applications of astronomy; and the reports of the United States Coast Survey show that he never failed to grasp opportunities for making observations promising to be useful in any branch of pure astronomy. The list of his published contributions contains many titles relating to eclipses, meteors, occultations and comets, and to atmospheric conditions affecting astronomical observations. His influence with JAMES LICK, while Mr. LICK was formulating plans for erecting the most powerful telescope in existence, was wise and potent, and perhaps even vital to a practical solution of Mr. LICK's problem. A review of DAVIDSON's activities in pure and applied astronomy, necessarily abbreviated, is herewith presented. There is little doubt that a review of his geographical work would show equally extensive contributions in that field.

Assistant DAVIDSON's first observing station on the Pacific Slope, in 1850, was located at Point Conception, the most prom-

inent and dangerous angle in the western coast-line of the United States. He determined the latitude and longitude of the station, the variation and dip of the magnetic needle, and reported upon the best location for the proposed light-house in that neighborhood. During the first four years other stations were occupied successively at Monterey, San Diego, Cape Disappointment (at the mouth of the Columbia River), Port Orford, Neah Bay (near the entrance to Puget Sound), at the Presidio of San Francisco, and at approximately twenty minor points. The longitudes of the principal stations were determined from observed positions of the Moon with reference to neighboring stars (Moon culminations), and from the observed times of occultations of the stars by the Moon, and the relative longitudes of the minor stations were determined by the transportation of chronometers. The modern methods of determining longitudes by telegraphic signals were of course not available. Coastwise travel in those days was by sailing vessels, and surf landings were unavoidable at many stations on the capes and points. There were occasionally personal risks from hostile natives, as at Neah Bay, where the observations were made from behind breastworks with men and guns constantly ready to repel attack.

The astronomical, magnetic, hydrographic and topographic data which were accumulated with extraordinary rapidity were woven by him into a report, as early as 1855, and issued as a guide to mariners. In the Coast Survey report for the year 1858 the superintendent refers to DAVIDSON's Directory for the Pacific Coast, as follows: "This useful work has been compiled by GEORGE DAVIDSON, Esq., Assistant in the Coast Survey, from the Coast Survey and other authentic data, embodying also the results of his own experience on the Coast, where he has been occupied in charge of geographical, triangulation and topographical parties since the commencement of the survey in 1849. Having thoroughly and peculiarly identified himself with the survey of the western coast from its beginning, and had occasion himself to know the necessities, facilities and dangers of its navigation, he has been in a position to prepare a particularly valuable directory for the use of mariners and navigators."

The partial solar eclipse of May 26, 1854, was observed with a small telescope, chiefly for times of contacts, by Mr. DAVIDSON from his station at Humboldt Bay. He observed the occultations of twenty-two stars of the *Pleiades* group on March 1, 1857, to strengthen the longitude determination of the San Francisco station. He observed, at San Francisco, the times of beginning and ending of the partial solar eclipse of March 25, 1857. He observed occultations of the *Pleiades*, March 26, 1860, on Ross Mountain, and the times of contacts in the partial solar eclipse of July 18, 1860, on Sonoma Mountain.

Mr. DAVIDSON was ordered to the Atlantic Coast service of the Survey late in the year 1860, where he remained until about 1866. After the purchase of Alaska from Russia, he was ordered to make a survey of the coast of Alaska with reference to the needs of navigators. The materials for this Directory were rapidly collected, in 1867, and this extensive work was published promptly. He was appointed assistant in charge of the Pacific Coast work of the Survey in 1868.

Mr. DAVIDSON's intensive work on the astronomical foundations of the Pacific surveys called his attention strongly to the weak points in existing instruments employed by the Survey, and his inventive genius suggested many improvements. A description of the DAVIDSON meridian instrument for determining time, longitude and latitude is published in the Survey report for 1867. This instrument was extensively used in subsequent work of the Coast Survey thruout the United States.

The construction of the Union and Central Pacific Railways and the establishing of telegraphic connection between the Atlantic and Pacific Coasts enabled the longitude determinations on the Pacific Coast to be placed upon an accurate basis for the first time. The Pacific end of the longitude comparisons with Harvard College Observatory was conducted by Mr. DAVIDSON in a temporary observatory set up for the purpose in Washington Square. Telegraphic signals were exchanged with Cambridge on twelve nights, between February 15 and April 4, 1869, through the courtesy of the Western Union Telegraph Company.

The total solar eclipse of August 7, 1869, was observed by Mr. DAVIDSON and his party on the Chilkah River, Alaska. The

times of contact were satisfactorily estimated and careful descriptions of eclipse phenomena were prepared and published.

In appreciation of Mr. DAVIDSON's services, the Regents of the University of California appointed him Honorary Professor of Geodesy and Astronomy in the University, dating from 1873.

In 1870, at the San Buena Ventura station, he recorded the flight of 556 meteors, and made a special report on the subject.

During a few weeks in the mid-summer of 1872 he occupied a station at Summit, the highest point on the Central Pacific Railway in the Sierra Nevada Mountains, altitude 7,200 feet. He tested the astronomical conditions as affecting astronomical observations, and was greatly impressed with the advantages of a high altitude. His report in the Coast Survey volume for 1872 places emphasis on the subject.

The transit of *Venus* had been observed in 1769 by M. CHAPPE DE L'AUTEROCHÉ at San Jose del Cabo in Lower California, but this observer had not determined, or at least had not published, the exact position of his observing station. On account of the interest attached to the transits of *Venus* which would occur in 1874 and in 1882, Mr. DAVIDSON in 1873 searched for the exact location occupied by DE L'AUTEROCHÉ. Though no evidences of the latter's occupation remained, the description of the observing station enabled Mr. DAVIDSON to locate the station, in his opinion, within a space of twenty feet square, and the co-ordinates of the observing station were accordingly determined.

Professor DAVIDSON was appointed by the United States Government Commission to observe the transit of *Venus* in Japan on December 8, 1874. Assisted by TITTMANN and EDWARDS, of the Survey, the preparations were carefully made, but unfortunately the expedition was rendered unfruitful by clouds at the critical times.

The total solar eclipse of January 11, 1880, was carefully and extensively observed from the summit of Santa Lucia Mountain by a Coast Survey party under Professor DAVIDSON's direction, and likewise by Professor FRISBIE of the United States Naval Observatory. All the observations were visual, and the results related to the estimated times of contacts, the appearances of the corona, prominences, etc.

He was appointed by the Government Transit of *Venus* Commission to direct the work of one of the parties for the observation of the transit of 1882. The observations were obtained successfully at Cerro Roblero, New Mexico.

His party observed the transit of *Mercury* at the Yolo Base, Sacramento Valley, on November 7, 1881.

Catalogs of star positions suited to the work of the Coast Survey field parties were compiled by DAVIDSON from time to time. The Report of the Survey for 1883 contains a catalog of 1278 time and circumpolar stars arranged for this purpose.

In the late 1880's the question of the variation of terrestrial latitudes was prominent, and observations at widely separated stations were urgently called for. As a labor of love Professor DAVIDSON undertook the observations of latitude pairs, by the Talcott-Horrebrow method, at his observatory in San Francisco. Between May, 1891, and August, 1892, approximately 2500 pairs of stars were observed for this purpose; to be exact, 5308 observations on 283 stars were secured. An additional series of observations was made by him in the years 1893-94. The results agreed with those secured at European, Atlantic Coast and Hawaiian stations, confirming the fact that the latitudes of points on the Earth's surface are constantly changing by minute amounts.

Professor DAVIDSON's programs of observation, whether for the determination of latitude, time and azimuth, of magnetic declination and dip, of refraction constants, or for research in pure astronomy on his own account, were characterized by the very great numbers of observations planned for and secured, as well as by the observance of precautions for ensuring that the individual observations be as accurate as possible.

It is a remarkable fact that the first investigating astronomical observatory planned for California, and in fact for the western half of the United States, the Lick Observatory, was on a large scale for its time. The first observatory *completed* in California, however, was that of Professor DAVIDSON. This was established in LaFayette Park, San Francisco, about 1879. It was erected at DAVIDSON's personal expense. It contained a 6.4-inch Clark refracting telescope. This instrument was used to observe the total solar eclipse of January 11, 1880, on Santa

Lucia Mountain; to observe several partial solar eclipses and the 1882 transit of *Venus*; to make drawings of the principal planets; and to observe star occultations and comets. The observatory was dismantled several years ago, following a permanent affection of Professor DAVIDSON's eyesight, which prevented him from making further observations.

There remains to be considered Professor DAVIDSON's relations to JAMES LICK and to the proposed Lick Observatory; and there can be no doubt that here also he rendered most useful service to the advancement of science. Professor DAVIDSON has prepared and published two statements describing these relations. The first one, prepared in 1892, is brief, and is contained in Dr. MILICENT W. SHINN's account of the founding and early scientific work of the Lick Observatory, in the *Overland Monthly* for November, 1892. Dr. SHINN is an editor of great ability, possessing well-balanced historical judgment, based upon a thoro university training, who was intensely interested in all questions relating to the origin of Lick Observatory. In preparing her historical article she fortunately had the advantage of personal interviews with Professor DAVIDSON, and of submitting the proof sheets to him. I quote from her paper:—

No one seems to know how or when the idea of a great telescope entered Mr. LICK's mind. It was there before he took any one into his confidence. . . . In February, 1873, he quite unexpectedly offered the Academy a piece of land on Market Street, the site of its present building. Professor GEORGE DAVIDSON, then president of the Academy, called to thank him, and Mr. LICK then told him of his purpose of leaving money for a great telescope. . . . Mr. LICK had no knowledge whatever of any of the auxiliaries needed by a telescope, or of the purposes of astronomy beyond bare discovery; and all this was left to Professor DAVIDSON to outline to him in the few months of their conferences. Out of the very interesting verbal narrative that Professor DAVIDSON has given me of this episode, he is willing to have in print at present only so much as is contained in the following memoranda, which he wishes me to leave in his (Professor DAVIDSON's) own words:

"I am not willing, at this time, to write the narrative of my relations with JAMES LICK from February, 1873, to August, 1874, but I give very briefly the following items of interest:

"JAMES LICK originally intended to erect the Observatory at Fourth and Market Streets. His ideas of what he wanted and what he should do were of the very vaguest character. It required months of careful



approaches and the proper presentation of facts to change his views on location. He next had a notion of locating it on the mountains overlooking his mill-site, near Santa Clara, and thought it would be a Mecca,—but only in the sense of a show.

“Gradually I guided his judgment to place it on a great elevation in the Sierra Nevadas, by placing before him the results of my experimental work at great elevations, as well as the experience of other high-altitude observers. At the same time, by my presentation of facts and figures of the cost and maintenance of other observatories, he named the sum of \$1,200,000 in one of his wills, as the sum to be set aside for founding the James Lick Observatory, and for its support.

“In making him acquainted with the size and performance of the telescopes of the larger observatories, I naturally mentioned the great reflector of Lord RosSE. That seemed to fire his ambition, and at the next interview he insisted on a refractor of six feet in diameter. It required long and patient explanations to get him down to forty inches, which was the diameter we finally adopted.

“In October, 1873, I obtained his permission to make known to the California Academy of Sciences the main facts of his intention to place the largest refracting telescope that could be constructed at an elevation of 10,000 feet in the Sierra Nevadas. I have not the announcement within reach, but it was published in the *Alta California* late in October, I think the 21st. A short time before that I had confidentially made the facts of LICK’s intention known to Leland Stanford and his wife.

“An eminent astronomer had nearly frustrated the whole project by urging Mr. LICK to adopt a reflecting telescope instead of a refractor; but he had a remarkably clear mechanical mind, and I had very little trouble in satisfying him of the weakness of the suggestion.

“Before I went to Washington for consultation with other observers for the transit of *Venus* expeditions in 1874, Mr. LICK held to the decision of the refractor at a great elevation, and details had been decided upon, although he had several times changed his will in other matters. Before departing I showed him that by the Code of California he could not then devise by will to any corporate body, and urged him to make a deed of trust.

“Upon my return I found he had made the deed of trust, and that some of the Pioneers had prevailed upon him to locate the observatory on the north shore of Lake Tahoe; and had prevailed upon him to reduce the \$1,200,000 to \$700,000.

“When he again changed his views, and determined to locate the observatory on the vastly inferior site of Mount Hamilton, I declined further conference with him.

“The whole of my intercourse with him was full of curious and interesting, and sometimes dramatic, incidents, that have never been sought by any one professing to write the history of the Lick Observatory.”

Professor DAVIDSON's second article, prepared in 1899 and published in the *University of California Magazine* for April, 1899, is too long for reproduction here. It is, in effect, an expansion of the memorandum prepared by him for Dr. SHINN's paper, as quoted above in full. It confirms all the important historical points in the memorandum. However, it is desirable to quote those of Professor DAVIDSON's sentences which relate to Mr. LICK's announcement of his plans for a great telescope. ". . . but my first meeting with Mr. LICK was in February, 1873, when another member and myself carried to Mr. LICK the thanks of the Society [California Academy of Sciences] for his unsolicited and munificent gift. After that meeting and at the request of Mr. LICK, my conferences with him were very frequent. . . . He kept himself thoroughly informed on what the Academy was doing, and seemed especially interested in astronomical matters, although he had never looked through a telescope or read a work on astronomy. In time he disclosed his intentions about a great telescope."

Professor DAVIDSON's point of view was clearly that of the intensely interested astronomer who desired to see the bequest expended in a practicable manner. The advice to construct a refractor instead of a great reflector was quite in harmony with astronomical opinions prevailing at that time, and the plan to construct a refractor six feet in diameter must certainly have failed. Whether the advice to select a location for the observatory in the Sierra Nevada Mountains, at an elevation of 10,000 feet, was wise and practicable, may be open to question at the present time, but this was certainly Professor DAVIDSON's strong and honest point of view. Over the misfortune that the promised sum of \$1,200,000 was reduced by Mr. LICK to \$700,000 we need not moralize. From the many side-lights thrown upon Mr. LICK's character, it is entirely possible that without Professor DAVIDSON's guidance at a critical period the plans for the construction of a useful telescope and observatory might have come to grief. It is also clear from the fact that Mr. LICK stood by his plans, notwithstanding his displeasure with his first board of trustees, resulting in their resignation, and in the appointment of a second board and finally of a third

board, that Mr. LICK was determined to get his telescope. We may all unite in expressing gratification that Professor DAVIDSON'S duties in the matter were performed so conscientiously and with unselfish singleness of purpose. The Lick Observatory was undoubtedly more successfully planned by virtue of Professor DAVIDSON'S help than it would have been without this help.

Professor DAVIDSON retained a strong interest in all astronomical subjects to the end. His death marked the passing of a great and useful man.

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## THE CORDOBA ZONES AND DURCHMUSTERUNG.<sup>1</sup>

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BY C. D. PERRINE.

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In 1891 Dr. THOME commenced the observations to continue the A. G. zone catalogs from  $-22^{\circ}$  to  $-37^{\circ}$ . The observing work was completed in 1900. The reduction and revision work is now completed. The first  $5^{\circ}$  zone ( $-22^{\circ}$  to  $-27^{\circ}$ ), comprising 15,975 stars, has been sent to the printer. The second  $5^{\circ}$  zone will be completed, ready for printing, by the end of the present year. The third zone will be finished about the end of 1914.

It seems highly desirable that this zone work should be extended to the pole as quickly as possible. In looking about for a quick method I have come to the conclusion that photography offers great advantages and am planning to continue the work by this means. It may be of interest to give an outline of the proposed plan.

The photographs will be taken with a doublet of 18<sup>cm</sup> aperture and 110<sup>cm</sup> focal length, stopped down to about 12 or 13<sup>cm</sup> to cover sharply a field  $5^{\circ}$  on a side, if possible.

For the zone catalog work it is planned to take overlapping plates, as is done for the astrographic work—so that a final catalog position will be the mean of four images. This should give, with the scale adopted, a satisfactory degree of accuracy. I expect the probable error of a single image to be not over a

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<sup>1</sup> Report presented at the Hamburg meeting of the Astronomische Gesellschaft, August, 1913.